UNIT 3

Necessities to Maintain Life

CHAPTER 3-1

Firecraft

Fire

In many survival situations, the ability to start a fire can make the difference between living and dying. Fire can fulfill many needs. It can provide warmth and comfort. It not only cooks and preserves food, it also provides warmth in the form of heated food that saves calories our body normally uses to produce body heat. You can use fire to purify water, sterilize bandages, signal for rescue, and provide protection from animals and the smoke from a fire can be used to discourage insects. It can be a psychological boost by providing peace of mind and companionship. You can also use fire to produce tools and weapons.

Avoid building a very large fire. Small fires require less fuel, are easier to control, and their heat can be concentrated. Never leave a fire unattended unless it is banked or contained. Banking a fire is done by scraping cold ashes and dry earth onto the fire, leaving enough air coming through the dirt at the top to keep the fuel smoldering. This will keep the fire safe and allow it to be rekindled from the saved coals.

Basic Fire Principles

To build a fire, it helps to understand the basic principles of a fire. Fuel (in a nongaseous state) does not burn directly. When you apply heat to a fuel, it produces a gas. This gas, combined with oxygen in the air, burns.

Understanding the concept of the fire triangle is very important in correctly constructing and maintaining a fire. The three essentials elements of the triangle represent air (oxygen), heat, and fuel. By limiting fuel, only a small fire is produced. If the fire is not fed properly, there is too much or too little fire. If you remove any of these, the fire will go out. The correct ration of these components is very important for a fire to burn at its greatest capability. The only way to learn this ration is to practice. Green fuel is difficult to ignite, and the fire must be burning well before it is used for fuel. Oxygen and heat must be accessible to ignite any fuel.

The survivor must take time and prepare well! Preparing all of the stages of fuel and all of the parts of the fire starting device is the key. To be successful at firecraft, one needs to practice and be patient.

Fire Material Selection

Tinder is any type of small material having a low flash point. It is easily ignited with a minimum of heat, even a spark. The tinder must be absolutely dry to be sure just a spark will ignite it. Tinder must be arranged to allow air (oxygen) between the hair-like, bone-dry fibers. The preparation of tinder for fire is one of the most important parts of -firecraft (fig. 3-1). Dry tinder is so critical that pioneers used extreme care to have some in a waterproof "tinder box" at all times. It may be necessary to have two or three stages of tinder to get the flames to a useful size. If you only have a device that generates sparks, charred cloth will be almost essential. It holds a spark for long periods, allowing you to put tinder on the hot area to generate a small flame. You can make charred cloth by heating cotton cloth until it turns black, but does not burn. Once it is black, you must keep it in an airtight container to keep it dry. Prepare this cloth well in advance of any survival situation. Add it to your individual survival kit.

Tinders include:

- The shredded bark from some trees and bushes.
- Cedar, birch bark, or palm fiber.
- Crushed fibers from dead plants.
- Fine, dry woodshavings, and straw/grasses.

- **Resinous** sawdust.
- Very fine pitch woodshavings (resinous wood from pine or sappy conifers).
- Bird or rodent nest linings.
- Seed down (milkweed, cattail, thistle).
- Charred cloth.
- Cotton balls or lint.
- Steel wool.
- Dry powdered sap from the pine tree family (also known as pitch).
- Paper.
- Foam rubber.

Kindling is the next larger stage of fuel material. It should also have a high combustible point. It is added to, or arranged over, the tinder in such a way that it ignites when the flame from the tinder reaches it. Again, this material should be absolutely dry to ensure rapid burning. Kindling is used to bring the burning temperature up to the point where larger and less combustible fuel material can be used.

Kindling includes:

- Dead dry small twigs or plant fibers.
- Dead dry thinly shaved pieces of wood, bamboo, or cane (always split bamboo as sections can explode).
- **Coniferous** seed cones and needles.
- "Squaw wood" from the underside of coniferous trees; dead, small branches next to the ground sheltered by the upper live part of the tree.
- Pieces of wood removed from the insides of larger pieces.
- Some plastics such as the spoon from an inflight ration.
- Wood which has been soaked or doused with flammable materials; that is, wax, insect repellent, petroleum fuels, and oil.
- Strips of **petrolatum** gauze from a first aid kit.
- Dry split wood burns readily because it is drier inside. Also the angular portions of the wood burn easier than the bark-covered round pieces because it exposes more surface to the flame. The splitting of all fuels will cause them to burn more readily.

Resinous: Any of numerous clear to translucent yellow or brown solid semisolid sticky substances of plant source.
Coniferous: A predominantly evergreen cone-bearing tree as a pine, spruce, hemlock, or fir.
Petrolatum: A neutral oily, odorless, tasteless substance obtained from petroleum and used in ointments and dressings.

Fuel is less combustible material that burns slowly and steadily once ignited. Unlike tinder and kindling, fuel does not have to be kept completely dry as long as there is enough kindling to raise the fuel to a combustible temperature. It is recommended that all fine materials be protected from moisture to prevent excessive smoke production. (Highly flammable liquids should not be poured on an existing fire. Even a smoldering fire can cause the liquids to explode and cause serious burns.) The type of fuel used will determine the amount of heat and light the fire will produce. Dry split hardwood trees (oak, hickory, monkey pod, ash) are less likely to produce excessive smoke and will usually provide more heat than soft woods. They may also be more difficult to break into usable sizes. Pine and other conifers are fast-burning and produce smoke unless a large flame is maintained. Rotten wood is of little value since it smolders and smokes. The weather plays an important role when selecting fuel. Standing or leaning wood is usually dry inside even if it is raining. In tropical areas, avoid selecting wood from trees that grow in swampy areas or those covered with mosses. Tropical soft woods are not usually a good fuel source. Trial and error is sometimes the best method to determine which fuel is best. After identifying the burning properties of available fuel, a selection can be made of the type needed.

Recommended fuel sources are:

- Dry standing dead wood and dry dead branches (those that snap when broken). Dead wood is easy to split and break. It can be pounded on a rock or wedged

between other objects and bent until it breaks.
- The insides of fallen trees and large branches may be dry even if the outside is wet. The heart wood is usually the last to rot.
- Green wood which can be made to burn is found almost anywhere, especially if finely split and mixed evenly with dry dead wood.
- In treeless areas, other natural fuels can be found. Dry grasses can be twisted into bunches. Dead cactus and other plants are available in deserts. Dry peat moss can be found along the surface of undercut stream banks. Dried animal dung, animal fats, and sometimes even coal can be found on the surface. Oil impregnated sand can also be used when available.

Site Location

Fire Location

The location of fire should be carefully selected. An old story is told of a mountain man who used his last match to light a fire built under a snow-covered tree. The heat from the fire melted the snow and it slid off the tree and put out the fire. For a survivor, this type of accident can be very bad or even deadly. Locate and prepare the fire carefully.

Fire Site Preparation

After a site is located, twigs, moss, grass, or duff should be cleaned away. Scrape at least a 3-foot diameter area down to bare soil for even a small fire. Larger fires require a larger area. If the fire must be built on snow, ice, or wet ground, survivors should build a platform of green logs or rocks. (Beware of wet or open rocks, they may explode when heated.)

There is no need to dig a hole or make a circle of rocks in preparation for fire building. Rocks may be placed in a circle and filled with dirt, sand, or gravel to raise the fire above the moisture from wet ground. The purpose of these rocks is to hold the platform only.

To get the most warmth from the fire, it should be built against a rock or log reflector (fig. 3-1). This will direct the heat into the shelter. Cooking fires can be walled-in by logs or stones. This will provide a platform for cooking utensils and serve as a windbreak to help keep the heat confined.

After preparing the fire, all materials should be placed together and arranged by size (tinder, kindling, and fuel) (fig. 3-2). As a rule of thumb, survivors should have three times the amount of tinder and kindling than is necessary for one fire. It is to their advantage to have too much than not enough. Having plenty of material on hand will prevent the possibility of the fire going out while additional material is gathered.

How to Light a Fire

Always light your fire from the upwind side. Make sure to lay your tinder, kindling, and fuel so that your fire will burn as long as you need it. Igniters provide the initial heat required to start the tinder burning. They fall into two categories: primitive methods and modern methods.

Survivors should arrange a small amount of kindling in a low pyramid, close enough together so flames can jump from one piece to another. A small opening should be left for lighting and air circulation.

Matches can be maintained by using a "shave stick," or by using a loosely tied kindling of thin, dry twigs. The match must be shielded from wind while igniting the shave stick. The stick can then be applied to the lower windward side of the kindling.

Small pieces of wood or other fuel can be laid gently on the kindling before lighting or can be added as the kindling begins to burn. The survivors can then place smaller pieces first, adding larger pieces of fuel as the fire begins to burn. They should avoid smothering the fire by crushing the kindling with heavy wood.

Survivors only have a limited number of matches or other instant fire-starting devices.

In a long-term situation, they should use these devices sparingly or carry fire with them when possible. Many primitive cultures carry fire (fire bundles) by using dry kindling or fiberous barks (cedar) encased in a bark. Others use torches. Natural fire bundles also work well for holding the fire (fig. 3-3).

The amount of oxygen must be just enough to keep the coals inside the dry kindling burning slowly. This requires constant attention to control the rate of the burning process. The natural fire bundle is constructed in a cross section as shown in figure 3-3.

Primitive Methods

A supply of matches, lighters, and other such devices will only last a limited time. Once the supply is depleted, they cannot be used again. If possible, before the need arises, survivors should become skilled at starting fires with more primitive means, such as friction, heat, or a sparking device. It is important that they always practice these procedures. The need to start a fire may arise at the most awkward times. One of the greatest aids a survivor can have for rapid fire starting is the “tinder box” previously mentioned. Using friction, heat, and sparks are very reliable methods for those who use them on a regular basis. Therefore, survivors must practice these methods. Survivors must be aware of the problems associated with the use of primitive heat sources. If the humidity is high in the immediate area, a fire may be difficult to ignite even if all other conditions are favorable. For primitive methods to be successful, the materials must be *bone dry*. The primitive people who use these ignition methods take great care to keep their tinder, kindling, and other fuels dry, even to the point of wrapping many layers of waterproof materials around it. *Preparation, practice,* and *patience* in the use of primitive fire-building techniques cannot be over emphasized. A key point in all primitive methods is to ensure that the tinder is not disturbed.

Flint and Steel. The direct spark method is the easiest of the primitive methods to use. The flint and steel method is the most reliable of the direct spark methods. Strike a flint or other hard, sharp-edged rock edge with a piece of carbon steel (stainless steel will not produce a good spark). This method requires a loose-jointed wrist and practice. When a spark has caught in the tinder, blow on it. The spark will spread and burst into flames (fig. 3-4).

Quartz: A hard crystalline, glassy silicon dioxide, SiO_2, occurring abundantly as a component of granite and sandstone or various pure crystal.

True flint is not necessary to produce sparks. Iron combustible material and **quartz** will also give off sparks even if they are struck against each other. Check the area and select the best spark-producing stone as a backup for the available matches. The sparks must fall on the tinder and then be blown or fanned to produce a coal and subsequent flame.

Synthetic flint, such as the so-called metal match, consists of the same type material used for flints in commercial cigarette lighters. Some contain magnesium which can be scraped into tinder and into which the spark is struck. The remains from the “match” burns hot and fast and will compensate for some moisture in tinder. If issued survival kits do not contain this item and the survivors choose to make one rather than buy it, lighter flints can be glued into a groove in a small piece of wood or plastic. The survivors can then practice striking a spark by scratching the flint with a knife blade. A 90-degree angle between the blade and flint works best. The device must be held close enough for the sparks to hit the tinder, but enough distance must be allowed to avoid accidentally extinguishing the fire. Cotton balls dipped in petroleum jelly make excellent tinder with flint and steel. When the tinder ignites, additional tinder, kindling, and fuel can be added.

Bamboo Fire Saw. The bamboo fire saw is constructed from a section of dry bamboo with both end joints cut off. The section of bamboo, about 12 inches in length, is split in half lengthwise. The inner wall of one of the halves (called the “running board”) is scraped or shaved thin. This is done in the middle of the running board. A notch to serve as a guide is cut in the outer sheath opposite the scraped area of the inner wall. This notch runs across the running board at a 90-degree angle (fig. 3-5.1-3).

The other half of the bamboo joint is further split in half lengthwise, and one of the resultant quarters is used as a "baseboard." One edge of the baseboard is shaved down to make a tapered cutting edge. The baseboard is then firmly secured with the cutting edge up. This may be done by staking it to the ground in any manner which does not allow it to move (fig. 3-5.4).

Tinder is made by scraping the outer sheath of the remaining quarter piece of the bamboo section. The scrapings (approximately a large handful) are then rubbed between the palms of the hands until all of the wood fibers are broken down and dust-like material no longer falls from the tinder. The ball of scrapings is then fluffed to allow maximum circulation of oxygen through the mass.

The finely shredded and fluffed tinder is placed in the running board directly over the shaved area, opposite the outside notch. Thin strips of bamboo should be placed lengthwise in the running board to hold the tinder in place. These strips are held stationary by the hands when grasping the ends of the running board.

A long, very thin sliver of bamboo (called the "pick") should be prepared for future use. One end of the running board is grasped in each hand, making sure the thin strips of bamboo are held securely in place. The running board is placed over the baseboard at a right angle, so that the cutting edge of the baseboard fits into the notch in the outer sheath of the running board. The running board is then slid back and forth as rapidly as possible over the cutting edge of the baseboard, with sufficient downward pressure to ensure enough friction to produce heat.

As soon as "billows" of smoke rise from the tinder, the running board is picked up. The pick is used to push the glowing red hot coals from the bottom of the running board into the mass of tinder. While the red hot coals are being pushed into the tinder, they are gently blown upon until the tinder bursts into flame (fig. 3-5.6).

As soon as the tinder bursts into flame, slowly add kindling in small pieces to avoid smothering the fire. Fuel is gradually added to produce the desired size fire. If the tinder is removed from the running board as soon as it flames, the running board can be reused by cutting a notch in the outer sheath next to the original notch and directly under the scraped area of the inner wall.

Bow and Drill. This is a friction method which has been used successfully for thousands of years. A spindle of yucca, elm, basswood, or any other straight grainwood (not softwood) should be made. The survivors should make sure that the wood is not too hard or it will create a glazed surface when friction is applied. The spindle should be 12 to 18 inches long and three-fourths inch in diameter. The sides should be octagonal, rather than round, to help create friction when spinning. Round one end and work the other end into a dull point. The round end goes to the top upon which the socket is placed. The socket is made from a piece of hardwood large enough to hold comfortably in the palm of the hand with the curved part up and the flat side down to hold the top of the spindle. Carve or drill a hole in this side and make it smooth so it will not cause undue friction and heat production. Grease or soap can be placed in this hole to prevent friction (fig. 3-6).

The bow is made from a stiff branch about 3 feet long and about 1 inch in diameter. This piece should have sufficient flexibility to bend. It is similar to a bow used to shoot arrows. Tie a piece of suspension line or leather thong to both ends so that it has the same tension as that of a bow. There should be enough tension for the spindle to twist comfortably.

The fireboard is made of the softwood and is about 12 inches long, three-fourths inch thick, and 3 to 6 inches wide. A small hollow should be carved in the fireboard. A V-shaped cut can then be made in from the edge of the board. This V-shape should extend into the center of the hollow where the spindle will make the hollow deeper The object of this

"V" cut is to create an angle which cuts off the edge of the spindle as it gets hot and turns to charcoal dust. This is the critical part of the fireboard and must be held steady during the operation of spinning the spindle.

While kneeling on one knee, the other foot can be placed on the fireboard as shown in figure 3-6 and the tinder placed under the fireboard just beneath the V-cut. Care should be taken to avoid crushing the tinder under the fireboard. Space can be obtained by using a small, three-fourths inch diameter stick to hold up the fireboard. This allows air into the tinder where the hot powder (spindle charcoal dust) is collected.

The bow string should be twisted once around the spindle. The spindle can then be placed upright into the spindle hollow (socket). The survivor may press the socket down on the spindle and fireboard. The entire device must be held steady with the hand on the socket braced against the leg or knee. The spindle should begin spinning with long even slow strokes of the bow until heavy smoke is produced. The spinning should become faster until the smoke is very thick. At this point, hot powder, that can be blown into a glowing ash, has been successfully produced. The bow and spindle can then be removed from the fireboard and the tinder can be placed next to the glowing ash making sure not to put it out. The tinder must then be rolled gently around the burning ash, and blow into the ashes, starting the tinder to burn. This part of the fire is most critical and should be done with care and planning.

The burning tinder is then placed into the waiting fire "lay" containing more tinder and small kindling. At no time in this process should the survivor break concentration or change sequence. The successful use of these primitive methods of fire starting will require a great deal of patience. Success demands dedication and practice.

The Fire Thong. The fire thong, another friction method, is used in only those tropical regions where rattan is found. The system is simple and consists of a twisted **rattan** thong or other strong plant fiber, 4 to 6 feet long, l less than 1 inch in diameter, and a 4-foot length of dry wood which is softer than rattan (**deciduous** wood) (fig. 3-7). Rub with steady but increasing rhythm.

Rattan: A climbing palm with very long tough stems.
Deciduous: Falling off or shed seasonally or at a certain stage of development in the life cycle.

Fire-Plow. The fire-plow (fig. 3-8) is a friction method of ignition. You rub a hardwood shaft against a softer wood base. To use this method, cut a straight groove in the base and plow the blunt tip of the shaft up and down the groove. The plowing action of the shaft pushes out small particles of wood fibers. Then, as you apply more pressure on each stroke, the friction ignites the wood particles.

Modern Methods

Modern igniters use modern devices—items we normally think of to start a fire.

Matches. Make sure these matches are waterproof. Also, store them in a water-proof container along with a dependable striker pad.

Burning Glass. If survivors have sunlight and a burning glass, a fire can be started with very little physical effort (fig. 3-9). Concentrate the rays of the Sun on tinder by using the lens of a compass, a camera lens, or the lens of a flashlight which magnifies; even a sphere-shaped piece of bottle glass may work. Hold the lens so that the brightest and smallest spot of concentrated light falls on the tinder. Once a wisp of smoke is produced, the tinder should be fanned or blown upon until the smoking coal becomes a flame. Powdered charcoal in the tinder will decrease the ignition time. Add kindling carefully as in any other type of fire. Practice will reduce the time it takes to light the tinder.

Flashlight Reflector. A flashlight reflector can also be used to start a fire (fig. 3-10). Place the tinder in the center of the reflector where the bulb is usually located. Push it up from the back of the hole until the hottest light is concentrated on the end and smoke results. If a cigarette is available, use it as a tinder for this method.

Metal Matches. Place a flat, dry leaf under your tinder with a portion exposed. Place the tip of the metal match on the dry leaf, holding the metal match in one hand and a knife in the other. Scrape your knife against the metal match to produce sparks. The sparks will hit the tinder. When the tinder starts to smolder, proceed as above.

Batteries. Another method of producing fire is to use the battery of the aircraft, vehicle, storage batteries etc. Using two insulated wires, connect one end of a wire to the positive post of the battery and the end of the other wire to the negative post. Touch the two remaining ends to the ends of a piece of noninsulated wire. This will cause a short in the electrical circuit and the noninsulated wire will begin to glow and get hot. Material coming into contact with this hot wire will ignite. Survivors should use caution when, attempting to start a fire with a battery. They should ensure that sparks or flames are not produced near the battery because explosive hydrogen gas is produced and can result in serious injury (fig. 3-11).

If fine grade steel wool is available, a fire may be started by stretching it between the positive and negative posts until the wire itself makes a red coal.

Gunpowder. Often, aircrew members will have ammunition with their equipment. If so, they would carefully extract the bullet from the shell casing, and use the gunpowder as tinder. A spark will ignite the powder. They should be very careful when extracting the bullet from the case.

Making a Fire with Special Equipment

The night end of the day-night flare can be used as a fire starter. This means, however, that survivors must weigh the importance of a fire against the loss of a night flare.

Some emergency kits contain small fire starters, cans of special fuels, windproof matches, and other aids. Survivors should save the fire starters for use in extreme cold and damp (moist) weather conditions.

The white plastic spoon (packed in various in-flight rations) may be the type that burns readily. The handle should be pushed deep enough into the ground to support the spoon in an upright position. Light the tip of the spoon. It will burn for about 10 minutes (long enough to dry out and ignite small tinder and kindling).

If a candle is available, it should be ignited to start a fire and thus prevent using more than one match. As soon as the fire is burning, the candle can be extinguished and saved for future use.

Tinder can be made more combustible by adding a few drops of flammable fuel/material. An example of this would be mixing the powder from an ammunition cartridge with the tinder. After preparing tinder in this manner, it should be stored in a waterproof container for future use. Care must be used in handling this mixture because the flash at ignition could burn the skin and clothing.

For thousands of years, Eskimos and other northern peoples have relied heavily upon oils from animals to heat their homes. A fat stove or "Koodlik" is used by the Eskimos to burn this fuel.

Survivors can improvise a stove from a ration can and burn any flammable oil-type liquid or animal fats available. Here again, survivors should keep in mind that if there is only a *limited* amount of animal fat, it should be eaten to produce heat inside the body.

Burning Aircraft Fuel

On barren lands in the arctic, aircraft fuel may be the only material survivors have available for fire.

A stove can be improvised to burn fuel, lubricating oil, or a mixture of both (fig. 3-12). The survivor should place 1 or 2 inches of sand or fine gravel in the bottom of a can or other container and add fuel. *Care should be used when lighting the fuel because it may explode.* Slots should be cut into the top of the can to let flame and smoke out, and holes punched just above the level of the sand to provide a draft. A mixture of fuel and oil will make the fire burn longer. If no can is available, a hole can be dug and filled with sand. Fuel is then poured on the sand and ignited. The survivor should not allow fuel to collect in puddles.

Lubricating oil can be burned as fuel by using a wick arrangement. The wick can be made of string, rope, rag, sphagnum (pale or ashy) moss, or even a cigarette and should be placed on the edge of a can filled with oil. Rags, paper, wood, or other fuel can be soaked in oil and thrown on the fire.

A stove can be made of any empty waxed carton by cutting off one end and punching a hole in each side near the unopened end. Survivors can stand the carton on the closed end and loosely place the fuel inside the carton. The stove can then be lit using fuel material left hanging over the end. The stove will burn from the top down.

Seal blubber makes a satisfactory fire without a container if gasoline or heat tablets are available to provide an initial hot flame (fig. 3-13). The heat source should be ignited on the raw side of the blubber while the fur side is on the ice. A square foot of blubber burns for several hours. Once the blubber catches fire, the heat tablets can be recovered. Eskimos light a small piece of blubber and use it to kindle increasingly larger pieces. The smoke from a blubber fire is dirty, black, and heavy. The flame is very bright and can be seen for several miles. The smoke will penetrate clothing and blacken the skin.

How To Build a Fire

There are several methods for laying a fire, each of which has advantages. Most fires are built to meet specific needs or uses, either heat, light, or preparing food and water. The following configurations are the most commonly used for fires and serve one or more needs (fig. 3-14).

Tepee

To make this fire, arrange the tinder and a few sticks of kindling in the shape of a tepee or cone. Light the center. As the tepee burns, the outside logs will fall inward, feeding the fire. This type of fire burns well even with wet wood.

The tepee fire can be used as a light source and has a concentrated heat point directly above the apex of the tepee which is ideal for boiling water.

To Build:

- Place a large handful of tinder on the ground in the middle of the fire site.
- Push a stick into the ground, slanting over the tinder.
- Then lean a circle of kindling sticks against the slanting stick, like a tepee, with an opening toward the windward side for draft.

To light the fire:

- Crouch in front of the fire lay with the back to the wind.
- Feed the fire from the downwind side, first with thin pieces of fuel, then gradually with thicker pieces.
- Continue feeding until the fire has reached the desired size. The tepee fire has one big drawback. It tends to fall over easily. However, it serves as an excellent starter fire.

Log Cabin

As the name implies, this lay looks similar to a log cabin. Log cabin fires give off a great amount of light and heat primarily because of the amount of oxygen which enters the fire. The log cabin fire creates a quick and large bed of coals and can be used for cooking or as the basis for a signal fire. If one person or a group of people are going to use the coals for cooking, the log cabin can be modified into a long fire or a keyhole fire.

Long Fire

The long fire begins as a trench, the length of which is laid to take advantage of existing wind. The long fire can also be built above ground by using two parallel green logs to hold the coals together. These logs should be at least 6 inches in diameter and situated so the cooking utensils will rest upon the logs. Two 1-inch thick sticks can be placed under both logs, one at each end of the long fire. This is done to allow the coals to receive more air.

Keyhole Fire

To construct a keyhole fire, a hole is dug in the shape of an old style keyhole and does the same thing as the long fire.

Pyramid

The pyramid fire looks similar to a log cabin fire except there are layers of fuel in place of a hollow framework. To lay this fire, place two small logs or branches parallel on the ground. Place a solid layer of small logs across the parallel logs. Add three or four more layers of logs or branches, each layer smaller than and at a right angle to the layer below it. Make a starter fire on top of the pyramid. As the starter fire burns, it will ignite the logs below it. This gives you a fire that burns downward, requiring no attention during the night. The advantage of a pyramid fire is that it burns for a long time resulting in a large bed of coals. This fire could possibly be used as an overnight fire when placed in front of a shelter opening.

Star Fire

This fire is used when conservation of fuel is necessary or a small fire is desired. It burns at the center of the “wheel” and must be constantly tended. Hardwood fuels work best with this type of fire.

“T” Fire

Used for large group cooking. The size of this lay may be adjusted to meet the group's cooking needs. In the top part of the “T,” the fire is constructed and maintained as long as needed to provide hot coals for cooking in the bottom part of the “T” fire lay. The number of hot coals may be adjusted in the lower part of the “T” fire lay to regulate the cooking temperature.

“V” Fire

This fire lay is a modification of the long fire. The shape allows a survivor to either block strong winds, or take advantage of light breezes. During high wind conditions, the vertex of the “V”—formed by the two outside logs—is placed in the direction from which the winds are coming, thereby sheltering the tinder (kindling) for ignition. Reversing the “lay” will funnel light breezes into the tinder (kindling) thereby facilitating ease of ignition.

Lean-To

To lay this fire (fig. 3-15), push a green stick into the ground at a 30-degree angle. Point the end of the stick in the direction of the wind. Place some tinder deep under this lean-to stick. Lean pieces of kindling against the lean-to stick. Light the tinder. As the kindling catches fire from the tinder, add more kindling.

Cross-Ditch

To use this method (fig. 3-16), scratch a cross about 30 centimeters in size in the ground. Dig the cross 7.5 centimeters deep. Put a large wad of tinder in the middle of the cross. Build a kindling pyramid above the tinder. The shallow ditch allows air to sweep under the tinder to provide a draft.

Useful Firecraft Hints

Conserve matches by only using them on properly prepared fires. They should never be used to light cigarettes or for starting unnecessary fires.

Carry some dry tinder in a waterproof container. It should be exposed to the Sun on dry days. Adding a little powdered charcoal will improve it. Cotton cloth is good tinder, especially if scorched or charred. It works well with a burning glass or flint and steel.

Remember that firemaking can be a difficult job in an arctic environment. The main problem is the availability of firemaking materials. Making a fire starts *well* before the match is lit. The fire must be protected from the wind. In wooded areas, standing timber and brush usually make a good windbreak but in open areas, some type of windbreak may have to be constructed. A row of snowblocks, the shelter of a ridge, or a pile of brush will work as a windbreak. It must be high enough to shield the fire from the wind. It may also act as a heat reflector if it is of solid material.

Remember, a platform will be required to prevent the fire from melting down through the deep snow and extinguishing it. A platform is also needed if the ground is moist or swampy. The platform can be made of green logs, metal, or any material that will not burn through very readily. Care must be taken when selecting an area for fire building. If the area has a large quantity of leafy material and/or peat, a platform is needed to avoid igniting the material as it will tend to smolder long after the flames of the fire are gone out. A smoldering peat fire is almost impossible to put out and may burn for years.

In forested areas, the debris on the ground should be cleared away to mineral soil, if possible, to prevent the fire from spreading.

The ignition source used to ignite the fire must be quick and easily operated with hand protection such as mittens. Any number of devices will work well—matches, candles, lighter, fire starter, metal matches, etc.

CHAPTER 3-2

Equipment

Survival planning is nothing more than realizing something could happen that would put you in a survival situation and, with that in mind, taking steps to increase your chances of survival. Thus, survival planning means preparation.

Preparation means having survival items and knowing how to use them. People who live in snow regions prepare their vehicles for poor road conditions. They put snow tires on their vehicles, add extra weight in the back for traction, and they carry a shovel, salt, and a blanket. Another example of preparation is finding the emergency exits on an aircraft when you board if for a flight. Preparation could also mean knowing your intended route of travel and familiarizing yourself with the area. Finally, emergency planning is essential.

Survivors in a survival situation have needs which must be met—food, water, clothing, shelters, etc. The survival kit contains equipment which can be used to satisfy these needs. Quite often, however, this equipment may not be available due to damage or loss. This chapter will address the care and use of issued equipment and improvising the needed equipment when not available.

Survival Kits

The environment is the key to the types of items you will need in your survival kit. How much equipment you put in your kit depends on how you will carry the kit. A kit carried on your body will have to be smaller than one carried in a vehicle. Always layer your survival kit, keeping the most important items on your body. Carry less important items on your load-bearing equipment. Place bulky items in the rucksack.

In preparing your survival kit, select items you can use for more than one purpose. If you have two items that will serve the same function, pick the one you can use for another function. Do not duplicate items, as this increases your kit's size and weight.

Your survival kit need not be elaborate. You need only functional items that will meet your needs and a case to hold the items. For the case, you might want to use a Band-Aid box, a first aid case, an ammunition pouch, or another suitable case. This case should be—

- Water repellent or waterproof.
- Easy to carry or attach to your body.
- Suitable to accept various-sized components.
- Durable.

In your survival kit, you should have:

- First aid items.
- Water purification tablets or drops.
- Fire starting equipment.
- Signaling items.
- Food gathering items.
- Shelter items.

Some examples of these items are:

- Lighter, metal match, waterproof matches.
- Snare wire.
- Signaling mirror.
- Wrist compass.
- Fish and snare line.
- Fishhooks.
- Candle.
- Small hand lens.
- Oxtetracycline tablets (diarrhea or infection).
- Water purification tablets.
- Solar blanket.
- Surgical blades.
- Butterfly sutures.
- Water Container
- Chap Stick
- Needle and thread
- Knife

Issued Equipment

Survival equipment is designed to aid survivors throughout their survival episode. To maintain its effectiveness, the equipment must be well cared for.

A knife is a survivor's most valuable tool in a survival situation. Imagine being in a survival situation without any weapons, tools, or equipment except your knife. It could happen! You might even be without a knife. You would probably feel helpless, but with the proper knowledge and skills, you can easily improvise needed items.

In survival situations, you may have to fashion any number and type of tools and equipment to survive. Examples of tools and equipment that could make your life much easier are ropes, rucksacks, clothes, nets, and so on.

Weapons serve a dual purpose. You use them to obtain and prepare food and to provide self-defense. A weapon can also give you a feeling of security and provide you with the ability to hunt on the move.

Electronic Equipment

Electronic signaling devices are by far the survivors' most important signaling devices. Therefore, it is important for survivors to properly care for them to ensure their continued effectiveness. In cold temperatures, the electronic signaling devices must be kept warm to prevent the batteries from becoming cold soaked. In a cold environment, if survivors speak directly into the microphone, the moisture from their breath may condense and freeze on the microphone, creating communication problems. Caution must be used when using the survival radios in a cold environment. If the radio is placed against the side of the face to communicate, frostbite could result. In a wet environment, survivors should make every effort to keep their electronic signaling devices dry.

Firearms

A firearm is a precision tool. It will continue functioning only as long as it is cared for. Saltwater, perspiration, dew, and humidity can all corrode or rust a firearm until it is inoperable. If dropped in saltwater, the survivor should wash the parts in freshwater and then dry and oil them. As an precision tool, one way to dry the firearm is to place it in boiling water and after removal, wipe off the excess moisture. The excess heat will evaporate most of the remaining moisture. Survivors should not use uncontrolled heat to dry the firearm as heat over 250ºF can remove the temper from the springs in a short time and weaken the action.

Any petroleum-based lubricants used in cold environments will stiffen or freeze causing the firearm to become inoperative. It would be better to completely clean the firearm and remove all lubricant. Metal becomes brittle from cold and is, therefore, more likely to break.

A firearm was not intended for use as a club, hammer, or pry bar. To use it for any purpose other than for which it was designed, would only result in damage to the firearm.

Clubs

You hold clubs, you do not throw them. As a weapon, the club does not protect you from enemy soldiers. It can, however, extend your area of defense beyond your fingertips. It also serves to increase the force of a blow without injuring yourself. There are three basic types of clubs. They are the simple, weighted, and sling club.

Simple Club

A simple club is staff or branch. It must be short enough for you to swing easily, but long enough and strong enough for you to damage whatever you hit. Its diameter should fit comfortably in your palm, but it should not be so thin as to allow the club to break easily upon impact. A straight-grained hardwood is best if you can find it.

Weighted Club

A weighted club is any simple club with a weight on one end. The weight may be a natural weight, such as a knot on the wood, or something added, such as a stone lashed to the club.

To make a weighted club, first find a stone that has a shape that will allow you to lash it securely to the club. A stone with a slight hourglass shape works well. If you cannot find a suitably shaped stone, you must fashion a groove or channel into the stone by a technique known as pecking. By repeatedly rapping the club stone with a smaller hard stone, you can get the desired shape.

Next, find a piece of wood that is the right length for you. A straight-grained hardwood is best. The length of the wood should feel comfortable in relation to the weight of the stone. Finally, lash the stone to the handle.

There are three techniques for lashing the stone to the handle: split handle, forked branch, and wrapped handle. The technique you use will depend on the type of handle you choose. See figure 3-17.

Sling Club

A sling club is another type of weighted club. A weight hangs 8 to 10 centimeters from the handle by a strong, flexible lashing (fig. 3-18). This type of club both extends the user’s reach and multiplies the force of the blow.

Edged Weapons

File

A file and sharpening stone are often packed in a survival kit. The file is normally used for axes, and the stone is normally used for knives. An old saying states that a sharp cutting tool is a safe cutting tool. Control of a cutting tool is easier to maintain if it is sharp, and the possibility of accidental injury is reduced.

A file should be used on an ax or hatchet. Survivors should file away from the cutting edge to prevent injury if the file should slip. The file should be worked from one end of the cutting edge to the other. The opposite side should be worked to the same degree. This will ensure that the cutting edge is even. After using a file, the stone may be used to hone the ax blade (fig. 3-19).

When using an ax, don't try to cut through a tree with one blow. Rhythm and aim are more important than force. Too much power behind a swing interferes with aim. When the ax is swung properly, its weight provides all the power needed.

Carving a new ax handle and mounting the ax head takes a great deal of time and effort. For this reason, a survivor should avoid actions which would require the handle to be changed. Using aim and paying attention to where the ax falls will prevent misses which could result in a cracked or broken handle. Survivors should not use an ax as a pry bar and should avoid leaving the ax out in cold weather where the handle may become brittle.

A broken handle is difficult to remove from the head of the ax. Usually the most convenient way is to burn it out (fig. 3-20). For a single-bit ax, bury the bit in the ground up to the handle, and build a fire over it. For a double-bit, a survivor should dig a small trench, lay the middle of the ax head over it, cover both “bits” with earth, and build the fire. The covering of earth keeps the flame from the cutting edge of the ax and saves its temper. A little water added to the earth will further ensure this protection.

When improvising a new handle, a survivor can save time and trouble by making a straight handle instead of a curved one like the original. Survivors should use a young, straight piece of hardwood without knots. The wood should be whittled roughly into shape and finished by shaving. A slot should be cut into the ax-head end of the handle. After it is fitted, a thin, dry wooden wedge can then be pounded into the slot. Survivors should use the ax awhile, pound the wedge in again, then trim it off flush with the ax. The handle must be smoothed to remove splinters. The new handle can be seasoned to prevent shrinkage by “scorching” it in the fire.

Knife

One of the most valuable items in any survival situation is a knife, since it has a large number of uses. A knife has three basic functions. It can puncture, slash or chop, and cut. A knife is also an invaluable tool used to construct other survival items. Unless the knife is kept sharp, however, it falls short of its potential. A knife should be sharpened only with a stone as repeated use of a file rapidly removes steel from the blade. In some cases, it may be necessary to use a file to remove plating from the blade before using the stone.

One of two methods should be used to sharpen a knife. One method is to push the blade down the stone in a slicing motion. Then turn the blade over and draw the blade toward the body (fig. 3-21).

The other method is to use a circular motion the entire length of the blade; turn the blade over and repeat the process. What is done to one side of the cutting edge should also be done to the other to maintain an even cutting edge (fig. 3-22).

Most sharpening stones available to survivors will be whetstones. Water should be applied to these stones. The water will help to float away the metal removed by sharpening and make cleaning of the stone easier. If a commercial whetstone is not available, a natural whetstone can be used. Any sandstone will sharpen tools, but a gray, clay-like sandstone gives better results. **Quartzite** should be avoided. Survivors can recognize quartzite instantly by scratching the knife blade with it—the quartz crystals will bite into steel. If no sandstone is available, granite or **crystalline** rock can be used. If granite is used, two pieces of the stone should be rubbed together to smooth the surface before use.

As with a sharp ax, a knife will save time and energy and be much safer.

You may find yourself without a knife or you may need another type knife or a spear. To improvise you can use stone, bone, wood, or metal to make a knife or spear blade.

Stone. To make a stone knife, you will need a sharp-edged piece of stone, a chipping tool, and a flaking tool. A chipping tool is a light, blunt-edged tool used to break off small pieces of stone. A flaking tool is a pointed tool used to break off thin, flattened pieces of stone. You can make a chipping tool from wood, bone, or metal, and a flaking tool from bone, antler tines, or soft iron (fig. 3-23).

Start making the knife by roughing out the desired shape on your sharp piece of stone, using the chipping tool. Try to make the knife fairly thin. Then using the flaking tool, press it against the edges. This action will cause flaking along the entire length of the edge you need to sharpen. Eventually, you will have a very sharp cutting edge that you can use as a knife.

Quartzite: A compact granular rock composed of quartz and derived from sandstone.
Crystalline: Relating to or made of crystal; clear like crystal.

Note*: Stone will make an excellent puncturing tool and a good chopping tool but will not hold a fine edge. Some stones such as chert or flint can have very fine edges.*

Bone. You can also use bone as an effective edged weapon. First, you will need to select a suitable bone. The larger bones, such as the leg bone of a deer or another medium-sized animal, are best. Lay the bone upon another hard object. Shatter the bone by hitting it with a heavy object, such as a rock. From the pieces, select a suitable pointed splinter. You can further shape and sharpen this splinter by rubbing it on a rough-surfaced rock. If the piece is too small to handle, you can still use it by adding a handle to it. Select a suitable piece of hardwood for a handle and lash the bone splinter securely to it.

Note: *Use the bone knife only to puncture. It will not hold an edge and it may flake or break if used differently.*

Wood. You can make edged weapons from wood. Use these only to puncture. Bamboo is the only wood that will hold a suitable edge. To make a knife using wood, first select a straight-grained piece of hardwood that is about 30 centimeters long and 2.5 centimeters in diameter. Fashion the blade about 15 centimeters long. Shave it down to a point. Use only the straight-grained portions of the wood. Do not use the core or pith, as it would make a weak point.

Harden the point by a process known as fire hardening. If a fire is possible, dry the blade portion over the fire slowly until lightly charred. The drier the wood, the harder the point. After lightly charring the blade portion, sharpen it on a coarse stone. If using bamboo and after fashioning the blade, remove any other wood to make the blade thinner from the inside portion of the bamboo. Removal is done this way because bamboo's hardest part is it outer layer. Keep as much of this layer as possible to ensure the hardest blade possible. When charring bamboo over a fire, char only the inside wood; do not char the outside.

Metal. Metal is the best material to make edged weapons. Metal, when properly designed, can fulfill a knife's three uses—puncture, slice or chop, and cut. First, select a suitable piece of metal, one that most resembles the desired end product. Depending on the size and original shape, you can obtain a point and cutting edge by rubbing the metal on a rough-surfaced stone. If the metal is soft enough, you can hammer out one edge while the metal is cold. Use a suitable flat, hard surface as an anvil and a smaller, harder object of stone or metal as a hammer to hammer out the edge. Make a knife handle from wood, bone, or other material that will protect your hand.

Other Materials. You can use other materials to produce edged weapons. Glass is a good alternative to an edged weapon or tool, if no other material is available. Obtain a suitable piece in the same manner as described for bone. Glass has a natural edge but is less durable for heavy work. You can also sharpen plastic—if it is thick enough or hard enough—into a durable point for puncturing.

Spear Blades

To make spears, use the same procedures to make the blade that you used to make a knife blade. Then select a shaft (a straight sapling) 1.2 to 1.5 meters long. The length should allow you to handle the spear easily and effectively. Attach the spear blade to the shaft using lashing. The preferred method is to split the handle, insert the blade, then wrap or lash it tightly. You can use other materials without adding a blade. Select a 1.2- to 1.5-meter long straight hardwood shaft and shave one end to a point. If possible, fire harden the point. Bamboo also makes an excellent spear. Select a piece 1.2 to 1.5 meters long. Starting 8 to 10 centimeters back from the end used as the point, shave down the end at a 45-degree angle (fig. 3-24). Remember, to sharpen the edges, shave only the inner portion.

Arrow Points

To make an arrow point, use the same procedures for making a stone knife blade. Chert, flint, and shell-type stones are best for arrow points. You can fashion bone like stone—by flaking. You can make an efficient arrow point using broken glass.

Whittling

Whittle means to cut, trim, or shape (a stick or piece of wood) by taking off bits with a knife. Survivors should be able to use the techniques of whittling to help save time, energy, and materials as well as to prevent injuries. They will find that whittling is a necessity in constructing triggers for traps and snares, shuttles and spacers, and other improvised equipment.

When whittling, survivors must hold the knife firmly and cut away from the body (fig. 3-25). Wood should be cut with the grain. Branches should be trimmed as shown in figure 3-26.

To cut completely through a piece of wood, a series of V-cuts should be made all the way around as in figure 3-27. Once the piece of wood has been severed, the pointed end can then be trimmed.

The thumb can be used to help steady the hand. Be sure and keep the thumb clear of the blade. To maintain good control of the knife, the right hand is steadied with the right thumb while the left thumb pushes the blade forward (fig. 3-28). This method is very good for trimming.

Felling Trees

To fell a tree, the survivor must first determine the direction in which the tree is to fall. It is best to fell the tree in the direction in which it is leaning. The lean of the tree can be found by using the ax as a plumb line (fig. 3-29). The survivor should then clear the area around the tree from underbrush and overhanging branches to prevent injury (fig. 3-30).

The survivor should make two cuts. The first cut should be on the leaning side of the tree and close to the ground and the second cut on the opposite side and a little higher than the first cut (fig. 3-31).

Falling trees often kick back and can cause serious injury (fig. 3-32), so survivors must ensure they have a clear escape route. When limbing a tree, start at the base of the tree and cut toward the top. This procedure will allow for easier limb removal and results in a smoother cut. For safety, the survivor should stand on one side of the trunk with the limb on the other.

To prevent damage to the ax head and possible physical injury, any splitting of wood should be done on a log as in figure 3-33. The log can also be used for cutting sticks and poles (fig. 3-34).

To make cutting of a sapling easier, bend it over with one hand, straining grain. A slanting blow close to the ground will cut the sapling (fig. 3-35).

Other Weapons

You can make other weapons such as the throwing stick, archery equipment, and the bola.

Throwing Stick

The throwing stick, commonly known as the rabbit stick, is very effective against small game (squirrels, chipmunks, and rabbits). The rabbit stick itself is a blunt stick, naturally curved at about a 45-degree angle. Select a stick with the desired angle from heavy hardwood such as oak. Shave off two opposite sides so that the stick is flat like a boomerang. You must practice the throwing technique for accuracy and speed. First, align the target by extending the nonthrowing arm in line with the mid to lower section of the target. Slowly and repeatedly raise the throwing arm up and back until the throwing stick crosses the back at about a 45-degree angle or is in line with the nonthrowing hip. Bring the throwing arm forward until it is just slightly above and parallel to the nonthrowing arm. This will be the throwing stick's release point. Practice slowly and repeatedly to attain accuracy.

Archery Equipment

You can make a bow and arrow (fig. 3-36) from materials available in your survival area.

While it may be relatively simple to make a bow and arrow, it is not easy to use one. You must practice using it a long time to be reasonably sure that you will hit your target. Also, a bow will not last very long before you have to make a new one. For the time and effort involved, you may well decide to use another type of weapon.

Bola

The bola is another weapon that is easy to make (fig. 3-37). It is especially effective for capturing running game or low-flying fowl in a flock. To use the bola, hold it by the center knot and twirl it above you head. Release the knot so that the bola flies toward your target. When you release the bola, the weighted cords will separate. These cords will wrap around and immobilize the fowl or animal that you hit.

Improvised Equipment

If issued equipment is inoperative, insufficient, or nonexistent, survivors will have to rely upon their ingenuity to manufacture the needed equipment. Survivors must determine whether the need for the item outweighs the work involved to manufacture it. They will also have to evaluate their capabilities. If they have injuries, will the injuries prevent them from manufacturing the item(s)?

Undue haste may not only waste materials, but also waste the survivors' time and energy. Before manufacturing equipment, they should have a plan in mind.

The survivors' equipment needs may be met in two different ways. They may alter an existing piece of equipment to serve more than one function, or they may also construct a new piece of equipment from available materials. Since the items survivors can improvise are limited only by their ingenuity, all improvised items cannot be covered in this chapter.

Many Air Force survivors have a parachute. This device can be used to improvise a variety of needed equipment items.

The parachute consist of (fig. 3-38):

- The pilot chute which deploys first and pulls the rest of the parachute out.
- The parachute canopy which consists of the apex (top) and the skirt or lower lateral band. The canopy material is divided by radial seams into 28 sections called gores. Each gore measures about 3 feet at the skirt and tapers to the apex. Each gore is further subdivided into four sections called panels. The canopy is normally divided into four colors. These colored areas are intended to aid the survivor in shelter construction, signaling, and camouflage.
- Fourteen suspension lines connect the canopy material to the harness assembly. Each piece of suspension line is 72 feet long from riser to rise and 22 feet long from riser to skirt and 14 feet from skirt to apex. The tensile strength of each piece of suspension line is 550 pounds. Each piece of suspension line contains seven to nine pieces of innercore with a tensile strength of 35 pounds. The harness assembly contains riser and webbing, buckles, snaps, "D" rings, and other hardware which can be used when improvising.

The whole parachute assembly should be considered as a resource. Every piece of material and hardware can be used.

For maximum use of the canopy, survivors must plan its disassembly. The quantity requirements for shelter, signaling, etc., should be thought out and planned for. Once these needs have been determined, the canopy may be cut up. The radial seam must be stretched tightly for ease of cutting. The radial seam can then be cut by holding the knife at an angle and following the center of the seam. With proper tension and the gentle pushing (or pulling) or a sharp blade there will be a controlled splitting of the canopy at the seam (fig. 3-39). It helps to secure the apex either to another individual or to an immobile object such as a tree.

When stripping the harness assembly, the seams of the webbing should be split so the maximum usable webbing is obtained. The harness material and webbing should not be randomly cut as it will waste much needed material.

One requirement in improvising is having available material. Parachute fabric, harness, suspension lines, etc., can be used for clothing. Needles are helpful for making any type of emergency clothing. Wise survivors should always have extra sewing needles hidden somewhere on their person. A good needle or sewing awl can be made from the can-opening key from the ration tin (fig. 3-40) or, as the Eskimos do, from a sliver of bone. Thread is usually available in the form of innercore. It will be to the survivor's benefit to collect small objects which may "come in handy." Wire, nails, buttons, a piece of canvas, or animal skin should not be discarded. Any such object may be worth its weight in gold when placed in a hip pocket or a sewing kit. Any kind of animal skin can be used for making clothing such as gloves or mittens or making a ground cover to keep the sleeping bag dry and clean. Small skins can be used for mending and for boot insoles. Mending and cleaning clothes when possible will pay dividends in health, comfort, and safety.

The improvised equipment survivors may need to make will probably involve sewing. The material to be sewn may be quite thick and hard to sew, and to keep from stabbing fingers and hands, a palm-type thimble can be improvised (fig. 3-41). A piece of webbing, leather, or other heavy material, with a hole for the thumb, is used. A flat rock, metal, or wood is used as the thimble and this is held in place by a doughnut-shaped piece of material sewn onto the palm piece. To use, the end of the needle with the eye is placed on the thimble and the thimble is then used to push the needle through the material to be sewn.

Sleeping Bag

Immediate action should be to use the whole parachute until conditions allow for improvising. A sleeping bag can be improvised by using four gores of parachute material or an equivalent amount of other materials (fig. 3-42). The material should be folded in half lengthwise and sewn at the foot. To measure the length, the survivor should allow an extra 6 to 10 inches in addition to the individual's height. The two raw edges can then be sewn together. The two sections of the bag can be filled with cattail down, goat' beard lichen, dry grass, insulation from aircraft walls, etc. The stuffed sleeping bag should then be quilted to keep the insulation from shifting. The bag can be folded in half lengthwise and the foot and open edges sewn. The length and width can be adjusted for the individual.

Insulating Bed

In addition to the sleeping bag, some form of ground insulation is advisable. An insulation mat will help insulate the survivor from ground moisture and the cold. Any nonpoisonous plants such as ferns and grasses will suffice. Leaves from a **deciduous** tree make a comfortable bed. If available, extra clothing, seat cushions, aircraft insulation, rafts, and parachute material may be used. In a **coniferous** forest, boughs from the trees would do well if the bed is constructed properly.

The survivor should start at the foot of the proposed bed and stick the cut ends in the ground at about a 45-degree angle and very close together. The completed bed should be slightly wider and longer than the body. If the ground is frozen, a layer of dead branches can

Deciduous: Falling off or shed seasonally or at a certain stage of development in the life cycle.
Coniferous: A predominantly evergreen cone-bearing tree, as a pine.

be used on the ground with the green boughs placed in the dead branches, similar to sticking them in the ground.

A bed made of branches should be a minimum of 12 inches thick before use. This will allow sufficient insulation between the survivor and the ground once the bed is compressed. The bed should be fluffed up and branches added daily to maintain its comfort and insulation capabilities.

Spruce branches have many sharp needles and can cause some discomfort. Also the needles on various types of pines are generally located on the ends of the branches, and it would take an abundance of pine branches to provide comfort and insulation. Fir branches on the other hand, have an abundance of needles all along the branches and the needles are rounded. These branches are excellent for beds, providing comfort and insulation (fig. 3-43).

Rawhide

Rawhide is a very useful material which can be made from any animal hide. Processing it is time consuming but the material obtained is strong and very durable. It can be used for making sheaths for cutting tools, lashing materials, ropes, etc.

Wire Saws

Wire or pieces of metal can be used to replace broken issued saws. With minor modifications, the survivor can construct a usable saw. A bow-saw arrangement will help to prevent the blade from flexing. A green sapling may be used for the bow as shown in figure 3-44.1. If a more durable saw is required and time permits, a bucksaw may be improvised (fig. 3-44.2).

Cooking Utensils

Ration tins can serve as adequate cooking utensils. If the end has been left intact as in figure 3-45, use a green stick long enough to prevent burning the hand while cooking. If the side has been left intact, a forked stick may be used to add support to the container.

Ropes and Knots

Basic Knowledge of Tying a Knot

A basic knowledge of correct rope and knot procedures will aid the survivor to do many necessary actions. Such actions as improvising equipment, building shelters, assembling packs, and providing safety devices require the use of proven techniques. Tying a knot incorrectly could result in ineffective improvised equipment, injury, or death.

Rope Terminology (fig. 3-46):

- *Bend*. A bend (called a knot in this chapter) is used to fasten two ropes together or to fasten a rope to a ring or loop.

- *Bight*. A bight is a bend or U-shaped curve in a rope.

- *Hitch*. A hitch is used to tie a rope around a timber, pipe, or post so that it will hold temporarily but can be readily untied.

- *Knot*. A knot is an interlacement of the parts of bodies, as cordage, forming a lump or knot or any tie or fastening formed with a cord, rope, or line, including bends, hitches, and splices. It is often used as a stopper to prevent a rope from passing through an opening.

- *Line*. A line (sometimes called a rope) is a single thread, string, or cord.

- *Loop*. A loop is a fold or doubling of the rope through which another rope can be passed. A temporary loop is made by a knot or a hitch. A permanent loop is made by a splice or some other permanent means.

- *Overhand Turn or Loop*. An overhand loop is made when the running end passes over the standing part.

- *Rope*. A rope (often called a line) is made of strands of fiber twisted or braided together.

- *Round Turn*. A round turn is the same as a turn, with running end leaving the circle in the same general direction as the standing part.

- *Running End*. The running end is the free or working end of a rope.

- *Standing End*. The standing end is the balance of the rope, excluding the running end.

- *Turn*. A turn describes the placing of a rope around a specific object such as a post, rail, or ring with the running end continuing in the opposite direction from the standing end.

- *Underhand Turn or Loop*. An underhand turn or loop is made when the running end passes under the standing part.

Whipping the Ends of a Rope

The raw, cut end of a rope has a tendency to untwist and should always be knotted or fastened in some manner. Whipping is one method of fastening the end of the rope. This method is particularly satisfactory because it does not increase the size of the rope. The whipped end of a rope will still thread through blocks or other openings. Before cutting a rope, place two whippings on the rope 1 or 2 inches apart and make the cut between the whippings (fig. 3-47.5). This will prevent the cut ends from untwisting immediately after they are cut. A rope is whipped by wrapping the end tightly with a small cord. Make a bight near one end of the cord and lay both ends of the small cord along one side of the rope (fig. 3-47.1). The bight should project beyond the end of the rope about one-half inch. The running end (b) of the cord should be wrapped tightly around the rope and cord (fig. 3-47.2) starting at the end of the whipping which will be farthest from the end of the rope. The wrap should be in the same direction as the twist of the rope strands. Continue wrapping the cord around the rope, keeping it tight, to within about one-half inch of the end. At this point, slip the running end (b) through the bight of the cord (fig. 3-47.3). The standing part of the cord (a) can then be pulled until the bight of the cord is pulled under the whipping and cord (b) is tightened (fig. 3-47.4). The ends of cord (a and b) should be cut at the edge of the whipping, leaving the rope end whipped.

Knots at End of the Rope

Overhand Knot. The overhand knot (fig. 3-48) is the most commonly used and the simplest of all knots. An overhand knot may be used to prevent the end of a rope from untwisting, to form a knot at the end of a rope, or as a part of another knot. To tie an overhand knot, make a loop near the end of the rope and pass the running end through the loop, pulling it tight.

Figure-Eight Knot. The figure-eight knot (fig. 3-49) is used to form a larger knot than would be formed by an overhand knot at the end of a rope. A figure-eight knot is used in the end of a rope to prevent the ends from slipping through a fastening or loop in another rope. To make the figure-eight knot, make a loop in the standing part, pass the running end around the standing part back over one side of the loop, and down through the loop. The running end can then be pulled tight.

Wall Knot. The wall knot (fig. 3-50) with a crown is used to prevent the end of a rope from untwisting when an enlargement is not objectionable. It also makes a desirable knot to prevent the end of the rope from slipping through small openings, as when rope handles are used on boxes. The crown or the wall knots may be used separately. To make the wall knot, untwist the strands for about five turns of the rope. A loop in strand (a) should be used and strand (b) brought down and around strand (a) (fig. 3-50.1). Strand (c) can then be brought around strand (b) and through the loop in strand (a) (fig. 3-50.2). The knot can then be tightened (fig. 3-50.4) by grasping the rope in one hand and pulling each strand tight. The strands point up or away from the rope. To make a neat, round knot, the wall knot should be crowned.

Bight: A loop or slack part of a rope.

Crown on Wall Knot. To crown a wall knot, the end of strand (a) (fig. 3-51.1) should be moved between strands (b) and (c). Next strand (c) is passed between strand (b) and the loop in strand (a) (fig. 3-51.2). Line (b) is then passed over line (a) and through the bight formed by line (c) (fig. 3-51.3). The knots can then be drawn tight and the loose strands cut. When the crown is finished, strands should point down or back along the rope.

Knots for Joining Two Ropes

Square Knot. The square knot (fig. 3-52) is used for tying two ropes of equal diameter together to prevent slippage. To tie the square knot, lay the running end of each rope together but pointing in opposite directions. The running end of one rope can be passed under the standing part of the other rope. Bring the two running ends up away from the point where they cross and crossed again (fig. 3-52.1). Once each running end is parallel to its own standing part (fig. 3-52.2), the two ends can be pulled tight. If each running end does not come parallel to the standing part of its own rope, the knot is called a “granny knot” (fig. 3-52.1). Because it will slip under strain, the granny knot should not be used. A square knot can also be tied by making a **bight** in the end of one rope and feeding the running end of the other rope through and around this bight. The running end of the second rope is routed from the standing side of the bight. If the procedure is reversed, the resulting knot will have a running end parallel to each standing part but the two running ends will not be opposite each other. This knot is called a “thief” knot (fig. 3-52.2). It will slip under strain and is difficult to untie. A square knot can be untied easily by grasping the bends of the two bights and pulling the knot apart.

Single Sheet Bend. The use of a single sheet bend (fig. 3-53), sometimes called a weaver's knot, is limited to tying together two dry ropes of unequal size. To tie the single sheet bend, the running end (a) (fig. 3-53) of the smaller rope should pass through a bight (b) in the larger rope. The running end should continue around both parts of the larger rope (fig. 3-53.2), and back under the smaller rope (fig. 3-53.3). The running end can then be pulled tight (fig. 3-53.4). This knot will draw tight under light loads but may loosen or slip when the tension is released.

Double Sheet Bend. The double sheet bend (fig. 3-54) works better than the single sheet bend for joining ropes of equal or unequal diameter, joining wet ropes, or for tying a rope to an eye. It will not slip or draw tight under heavy loads. To tie a double sheet bend, a single sheet bend is tied first. However, the running end is not pulled tight. One extra turn is taken around both sides of the bight in the larger rope with the running end for the smaller rope. Then tighten the knot.

Carrick Bend. The Carrick bend (fig. 3-55) is used for heavy loads and for joining thin cable or heavy rope. It will not draw tight under a heavy load. To tie a Carrick bend, a loop is formed (fig. 3-55.1) in one rope. The running end of the other rope is passed behind the standing part (fig. 3-55.2) and in front of the running part of the rope in which the loop has been formed. The running end should then be woven under one side of the loop (fig. 3-55.3), through the loop, over the standing part of its own rope (fig. 3-55.4), down through the loop, and under the remaining side of the loop (fig. 3-55.5).

Knots for Making Loops

Bowline. The bowline (fig. 3-56) is a useful knot for forming a loop in the end of a rope. It is also easy to untie. To tie the bowline, the running end (a) of the rope passes through the object to be affixed to the bowline and forms a loop (b) (fig. 3-56.1) in the standing part of the rope. The running end (a) is then passed through the loop from underneath (fig. 3-56.2) and around the standing part of the rope (fig. 3-56.3), and back through the loop from the top (fig. 3-56.4). The running end passes down through the loop parallel to the rope coming up through the loop. The knot is then pulled tight.

Double Bowline. The double bowline (fig. 3-57) with a slip knot is a rigging used by tree surgeons who work alone in trees for extended periods. It can be made and operated by one person and is comfortable as a sling or boatswain's chair (fig. 3-58). A small board with notches as a seat adds to the personal comfort of the user.

Rolling or Mangos Hitch. A rolling or Mangos hitch (fig. 3-59) is a safety knot designed to make a running end fast to a suspension line with a nonstop grip yet it can be released by hand pressure bending the knot downward. The running end (a) (fig. 3-59.1) is passed around the suspension line (b) twice, making two full turns downward (fig. 3-59.2). The running end (a) is then turned upward over the two turns (fig. 3-59.3), again around the suspension line, and under itself (fig. 3-59.4). This knot is excellent for fastening a rope to itself, a larger rope, a cable, a timber, or a post.

Running Bowline. The running bowline (fig. 3-60) is the basic air transport rigging knot. It provides a sling of the choker type at the end of a single line and is generally used in rigging. To tie a running bowline, make a bight (b) (fig. 3-60.1) with an overhand loop (c) made in the running end (a). The running end (a) is passed around the standing part, through the loop (c) (fig. 3-60.2), under, then back over the side of the bight, and back through the loop (c) (fig. 3-60.3).

Bowline on a Bight. It is sometimes desirable to form a loop at some point in a rope other than at the end. The bowline on a bight (fig. 3-61) can be used for this purpose. It is easily untied and will not slip. The same knot can be tied at the end of the rope by doubling the rope for a short section. A doubled portion of the rope is used to form a loop (b) (fig. 3-61.1) as in the case of the bowline. The bight end (a) of the doubled portion is passed up through the loop (b), back down (fig. 3-61.2), up around the entire knot (fig. 3-61.3), and tightened (fig. 3-61.4).

Spanish Bowline. A Spanish bowline (fig. 3-62) can be tied at any point in a rope, either at a place where the line is doubled or at an end which has been doubled back. The Spanish bowline is used in rescue work or to give a two-fold grip for lifting a pipe or other round object in a sling. To tie the Spanish bowline, a doubled portion of the rope is held in the left hand with the loop up and the center of the loop is turned back against the standing parts to form two loops (fig. 3-62.1) or “rabbit ears.” The two rabbit ears (c) and (d) are moved until they partly overlap each other (fig. 3-62.2). The top of the loop nearest the person is brought down toward the thumb of the left hand, being sure it is rolled over as it is brought down. The thumb is placed over this loop (fig. 3-62.3) to hold it in position. The top of the remaining loop is grasped and brought down, rolling it over and placing it under the thumb. There are now four small loops, (c, d, e, and f) in the rope. The lower left-hand loop (c) is turned one-half turn and inserted from front to back of the upper left-hand loop (e). The lower right-hand loop (d) is turned and inserted through the upper right-hand loop (f) (fig. 3-62.4). The two loops (c and d) which have been passed through are grasped and the rope pulled tight (fig. 3-62.5).

French Bowline. The French bowline (fig. 3-63) is sometimes used as a sling for lifting injured people. When used in this manner, one loop is used as a seat and the other loop is used around the body under the arms. The weight of the injured person keeps the two loops tight so that the victim cannot fall out and for this reason, it is particularly useful as a sling for someone who is unconscious. The French bowline is started in the same way as the simple bowline. Make a loop (a) (fig. 3-63.1) in the standing part of the rope. The running end (b) is passed through the loop from underneath and a separate loop (c) is made (fig. 3-63.2). The running end (b) is passed through the loop (a), again from underneath (fig. 3-63.3), around the back of the standing part and back through the loop (a) so that it comes out parallel to the looped portion. The standing part of the rope is pulled to tighten the knot (fig. 3-63.4), leaving two loops (c and d).

Harness Hitch. The harness hitch (fig. 3-64) is used to form a nonslipping loop in a rope. To make the harness hitch, form a bight (a) (fig. 3-64.1) in the running end of the rope. Hold this bight in the left hand and form a second bight (b) in the standing part of the rope. The right hand is used to pass bight (b) over bight (a) (fig. 3-64.2). Holding all loops in place with the left hand, the right hand is inserted through bight (a) behind the upper part of bight (b) (fig. 3-64.3). The bottom (c) of the first loop is grasped and pulled up through the entire knot pulling it tight (figs. 3-64.3 and 3-64.4).

Hitches, Lashing, and Cordages

Half Hitch

The half hitch (fig. 3-65.1) is used to tie a rope to a timber or to another larger rope. It is not a very secure knot or hitch and is used for temporarily securing the free end of a rope. To tie a half hitch, the rope is passed around the timber, bringing the running end around the standing part, and back under itself.

Timber Hitch

The timber hitch (fig. 3-65.2) is used for moving heavy timbers or poles. To make the timber hitch, a half hitch is made and similarly the running end is turned about itself at least another time. These turns must be taken around the running end itself or the knot will not tighten against the pull.

Timber Hitch and Half Hitch

To get a tighter hold on heavy poles for lifting or dragging a timber hitch and half hitch are combined (fig. 3-65.3). The running end is passed around the timber and back under the standing part to form a half hitch. Further along the timber, a timber hitch is tied with the running end. The strain will come on the half hitch and the timber hitch will prevent the half hitch from slipping.

Clove Hitch

A clove hitch (fig. 3-65.4) is used to fasten a rope to a timber, pipe, or post. It can be tied at any point in a rope. To tie a clove hitch in the center of the rope, two turns are made in the rope close together. They are twisted so that the two loops lay back-to-back. These two loops are slipped over the timber or pipe to form the knot. To tie the clove hitch at the end of a rope, the rope is passed around the timber in two turns so that the first turn crosses the standing part and the running end comes up under itself on the second turn.

Two Half Hitches

A quick method for tying a rope to a timber or pole is the use of two half hitches. The running end of the rope is passed around the pole or timber, and a turn is taken around the standing part and under the running end. This is one half hitch. The running end is passed around the standing part of the rope and back under itself again.

Round Turn and Two Half Hitches

Another hitch used for fastening a rope to a pole, timber, or spar is the round turn and two half hitches (fig. 3-66). The running end of the rope is passed around the pole or spar in two complete turns, and the running end is brought around the standing part and back under itself to make a half hitch. A second half hitch is made. For greater security, the running end of the rope should be secured to the standing part.

Fisherman's Bend

The fisherman's bend (fig. 3-67) is used to fasten a cable or rope to an anchor, or for use where there will be a slackening and tightening motion in the rope. To make this bend, the running end of the rope is passed in two complete turns through the ring or object to which it is to be secured. The running end is passed around the standing part of the rope and through the loop which has just been formed around the ring. The running end is then passed around the standing part in a half hitch. The running end should be secured to the standing part.

Sheepshank

A sheepshank (fig. 3-68) is a method of shortening a rope, but it may also be used to take the load off a weak spot in the rope. To make the sheepshank (which is never made at the end of a rope), two bights are made in the rope so that three parts of the rope are parallel. A half hitch is made in the standing part over the end of the bight at each end.

Speir Knot

A Speir knot (fig. 3-69) is used when a fixed loop, a nonstop knot, and a quick release are required. It can be tied quickly and released by a pull on the running end. To tie the Speir knot, the running end (a) is passed through a ring (fig. 3-69.1) or around a pipe or post and brought back on the left side of the standing part (b). Both hands are placed, palms up, under both parts of the rope with the left hand higher than the right hand; grasping the standing part (b) with the left hand and the running end (a) with the right hand. The left hand is moved to the left and the right hand to the right (fig. 3-69.2) to form two bights (c and d). The left hand is twisted a half turn toward the body so that bight (c) is twisted into a loop (fig. 3-69.3). Pass bight (d) over the rope and down through the loop (c). The Speir knot is tightened by pulling on the bight (d) and the standing part (b) (fig. 3-69.4).

Rolling Hitch (Pipe or Pole*)*

The rolling hitch (pipe or pole) (fig. 3-70) is used to secure a rope to a pipe or pole so that the rope will not slip. The standing part (a) of the rope is placed along the pipe or pole (fig. 3-70.1) extending in the direction opposite to the direction the pipe or pole will be moved. Two turns (b) are taken with the running end around the standing part (a) and the pole (fig. 3-70.2). The standing part (a) of the rope is reversed so that it is leading off in the direction in which the pole will be moved (fig. 3-70.3) and two turns are taken (c) (fig. 3-70.4) with the running end (d). On the second turn around, the running end (d) is passed under the first turn (c) to secure it (fig. 3-70.5). To make this knot secure, a half hitch (e) (fig. 3-70.6) is tied with the standing part of the rope 1 or 2 feet above the rolling hitch.

Blackwall Hitch

The blackwall hitch (fig. 3-71) is used for fastening a rope to a hook. To make the blackwall hitch, a bight of the rope is placed behind the hook. The running end (a) and standing part (b) are crossed through the hook so that the running end comes out at the opposite side of the hook and under the standing part.

Catspaw. A catspaw can be made at the end of a rope (fig. 3-72) for fastening the rope to a hook. Grasp the running end (a) of the rope in the left hand and make two bights (c and d) in the standing part (b) (3-72.1). Hold these two bights in place with the left hand and take two turns about the junction of the two bights with the standing part of the rope. Slip the two loops (c and d) so formed over the hook (fig. 3-72.3).

Scaffold Hitch. The scaffold hitch (fig. 3-73) is used to support the end of a scaffold plank with a single rope. To make the scaffold hitch, the running end of the rope is laid across the top and around the plank, then up and over the standing part (fig. 3-73.1). A doubled portion of the running end is brought back under the plank to form a bight (b) at the opposite side of the plank (fig. 3-73.2). The running end is taken back across the top of the plank) until it can be passed through the bight (b) (fig. 3-73.3). A loop is made (c) in the standing part above the plank. The running end is passed through the loop (c) around the standing part, and back through the loop (c) (figs. 3-73.4 and 3-73.5).

Barrel Slings. Barrel slings can be made to hold barrels horizontally or vertically. To sling a barrel horizontally (fig. 3-74), a bowline is made with a long bight. The rope at the bottom of the bight is brought up over the sides of the bight. The two “ears” are thus moved forward over the end of the barrel. To sling a barrel vertically (fig. 3-75) the rope is passed under the barrel and up to the top. An overhand knot is made (a) on top (fig. 3-75.1). With a slight tension on the rope, the two parts (fig. 3-75.2) of the overhand knot are grasped, separated and pulled down to the center of the barrel (b and c). The rope is pulled snug and a bowline tied (d) over the top of the barrel (fig. 3- 75.3).

Lashing Material

Many materials are strong enough for use as lashing and cordage. A number of natural and man-made materials are available in a survival situation. For example, you can make a cotton web belt much more useful by unraveling it. You can then use the string for other purposes (fishing line, thread for sewing, and lashing).

The best natural material for lashing small objects is muscles. You can make a lash from the muscles of large game, such as deer. Remove the muscles from the game and dry them completely. Smash the dried muscles so that they separate into fibers. Moisten the fibers and twist them into a continuous strand. If you need stronger lashing material, you can braid the strands. When you use muscles for small lashings, you do not need knots as the moistened muscle is sticky and it hardens when dry.

You can shred and braid plant fibers from the inner bark of some trees to make cord. You can use the linden, elm, hickory, white oak, mulberry, chestnut, and red and white cedar trees. After you make the cord, test it to be sure it is strong enough for your purpose. You can make these materials stronger by braiding several strands together.

You can use rawhide for larger lashing jobs. Make rawhide from the skins of medium or large game. After skinning the animal, remove any excess fat and any pieces of meat from the skin. Dry the skin completely. You do not need to stretch it as long as there are no folds to trap moisture. You do not have to remove the hair from the skin. Cut the skin while it is dry. Make cuts about 6 millimeters wide. Start from the center of the hide and make one continuous circular cut, working clockwise to the hide’s outer edge. Soak the rawhide for 2 to 4 hours or until it is soft. Use it wet, stretching it as much as possible while applying it. It will be strong and durable when it dries.

Lashing

There are numerous items which require lashings for construction; for example, shelters, equipment racks, and smoke generators. Three types of lashings will be discussed here--the square lash, the diagonal lash, and the shear lash.

Square Lash. Square lashing is started with a clove hitch around the log, immediately under the place where the crosspiece is to be located (fig. 3-76.1). In laying the turns, the rope goes on the outside of the previous turn around the crosspiece, and on the inside of the previous turn around the log. The rope should be kept tight (fig. 3-76.2). Three or four turns are necessary. Two or three "frapping" or securing turns are made between the crosspieces (fig. 3-76.3). The rope is pulled tight; this will bind the crosspiece tightly together. It is finished with a clove hitch around the same piece that the lashing was started on (fig. 3-76.4). The square lash is used to secure one pole at right angles to another pole. Another lash that can be used for the same purpose is the diagonal lash.

Diagonal Lash. The diagonal lash is started with a clove hitch around the two poles at the point of crossing. Three turns are taken around the two poles (fig. 3-77.1). The turns lie beside each other, not on top of each other. Three more turns are made around the two poles, this time crosswise over the previous turns. The turns are pulled tight. A couple of frapping turns are made between the two poles, around the lashing turns, making sure they are tight (fig. 3-77.2). The lashing is finished with a clove hitch around the same pole the lash was started on (fig. 3-77.3).

Shear Lash. The shear lash is used for lashing two or more poles in a series. The desired number of poles are placed parallel to each other and the lash is started with a clove hitch on an outer pole (fig. 3-78.1). The poles are then lashed together, using seven or eight turns of the rope laid loosely beside each other (fig. 3-78.2). Make frapping or securing turns between each pole (fig. 3-78.3). The lashing is finished with a clove hitch on the pole opposite that on which the lash was started (fig. 3-78.4).

Making Ropes and Cordage

Almost any natural fibrous material can be spun into good serviceable rope or cord, and many materials which have a length of 12 to 24 inches or more can be braided. Ropes up to 3 and 4 inches in diameter can be "laid" by four people, and tensile strength for bush-made rope of 1-inch diameter range from 100 pounds to as high as 3,000 pounds.

Tensile Strength. Using a three-lay rope of 1-inch diameter as standard, the following table of tensile strengths may serve to illustrate general strengths of various materials. For safety's sake, the lowest figure should always be regarded as the tensile strength.

Green Grass	100 lbs to 250 lbs
Bark Fiber	500 lbs to 1,500 1bs
Palm Fiber	650 lbs to 2,000 lbs
Sedges	2,000 lbs to 2,500 lbs
Monkey Rope (Lianas)	560 lbs to 700 lbs
Lawyer Vine (Calamus)..	½-inch diam, 1,200 1bs

Note: *Doubling the diameter quadruples the tensile strength half the diameter reduces the tensile strength to one-fourth.*

Principles of Ropemaking Materials. To discover whether a material is suitable for rope making, it must have four qualities:

- It must be reasonably long in the fiber.
- It must have "strength."
- It must be pliable.
- It must have "grip" so the fibers will "bite" onto one another.

Natural Cordage Selection. Before making cordage, there are a few simple tests you can do to determine you material's suitability. First, pull on a length of the material to test for strength. Next, twist it between your fingers and roll the fibers together. If it withstands this handling and does not snap apart, tie an overhand knot with the fibers and gently tighten. If the knot does not break, the material is usable. Figure 3-79 shows various methods of making cordage.

Where to Find Suitable Material. These qualities can be found in various types of plants, in ground vines, in most of the longer grasses, in some of the water reeds and rushes, in the inner barks of many trees and shrubs, and in the long hair or wool of many animals.

Obtaining Fibers for Making Ropes. Some green freshly gathered materials may be "stiff" or unyielding. When this is the case, it should be passed through hot flames for a few moments. The heat treatment should cause the sap to burst through some of the cell structure, and the material thus becomes pliable. Fibers for rope making may be obtained from many sources such as:

- Surface roots of many shrubs and trees have strong fibrous bark.
- Dead inner bark of fallen branches of some species of trees and in the new growth of many trees such as willows.
- The fibrous material of many water and swamp growing plants and rushes.
- Many species of grass and weeds.
- Some seaweeds.
- Fibrous material from leaves, stalks, and trunks of many palms.
- Many fibrous-leaved plants such as the aloes.

Gathering and Preparing Materials. There may be a high content of vegetable gum in some plants. This can often be removed by soaking the plants in water, by boiling, or by drying the material and “teasing” it into thin strips.

Some of the materials have to be used green if any strength is required. The materials that should be green include the sedges, water rushes, grasses, and **lianas**.

Liana: Any of various high-climbing, usually woody vines common in the tropics.

Palm fiber is harvested in tropical or subtropical regions. It is found at the junction of the leaf and the palm trunk, or it will be found lying on the ground beneath many palms. Palm fiber is a “natural” for making ropes and cords.

Fibrous matter from the inner bark of trees and shrubs is generally more easily used if the plant is dead or half dead. Much of the natural gum will have dried out and when the material is being teased, prior to spinning, the gum or resin will fall out in fine powder.

Making a Cord by Spinning with the Fingers: Use any material with long strong threads or fibers which have been previously tested for strength and flexibility. The fibers are gathered into loosely held strands of even thickness. Each of these strands is twisted clockwise. The twist will hold the fibers together. The strands should be formed $^{1}/_{8}$ inch diameter. As a general rule, there should be about 15 to 20 fibers to a strand. Two, three, or four of these strands are later twisted together, and this twisting together or “laying” is done with a counterclockwise twist, while at the same time, the separate strands which have not yet been laid up are twisted clockwise. Each strand must be of equal twist and thickness.

Figure 3-80 shows the general direction of twist and the method whereby the fibers are bonded into strands. In a similar manner, the twisted strands are put together into lays, and the lays into ropes.

The person who twists the strands together is called the “layer” and must see that the twisting is even, the strands are uniform, and the tension on each strand is equal. In “laying,” care must be taken to ensure each of the strands is evenly “laid up;” that is, one strand does not twist around the other one.

When spinning fine cords for fishing lines, snares, etc., considerable care must be taken to keep the strands uniform and the lay even. Fine thin cords of no more than 1/32-inch thickness can be spun with the fingers and are capable of taking a breaking strain of 20 to 30 pounds or more.

Normally two or more people are required to spin and lay up the strands for cord. However, many native people spin cord unaided. They twist the material by running the flat of the hand along the thigh, with the fibrous material between hand and thigh; and with the free hand, they feed in fiber for the next "spin." Using this technique, one person can make long lengths of single strands. This method of making cord or rope with the fingers is slow if any considerable length of cord is required.

An easier and simpler way to rapidly make lengths of rope from 50 to 100 yards or more in length is to make a rope machine and set up multiple spinners in the form of cranks. Figure 3-81 shows the details of rope spinning.

To use a rope machine, each feeder holds the materials under one arm and with one free hand feeds it into the strand which is being spun by the crank. The other hand lightly holds the fibers together till they are spun. As the lightly spun strands are increased in length, they must be supported on crossbars. They should not be allowed to lie on the ground. Spin strands from 20 to 100 yards before laying up. The material should not be spun in too thickly. Thick strands do not help strength in any way, rather, they tend to make a weaker rope.

Setting Up a Rope Machine

When spinning ropes of 10 yards or longer, it is necessary to set crossbars every 2 or 3 yards to carry the strands as they are spun. If crossbars are not set up, the strands or rope will sag to the ground, and some of the fibers will tangle up with grass, twigs, or dirt on the ground. Also, the twisting of the free end may either be stopped or interrupted and the strand will be unevenly twisted.

The easiest way to set up crossbars for the rope machine is to drive pairs of stakes into the ground about 6 feet apart and at intervals of about 6 to 10 feet. The crossbars must be smooth and free from twigs and loose portions of bark that might twist in with the spinning strands.

The crossbar (a) is supported by two uprights and pierced to take the cranks (b). These cranks can be made out of natural sticks, **morticed** slab, and pegs, or if available, bent wire. The connecting rod (c) enables one person to turn all cranks clockwise at once. Crossbars supporting the strands as they are spun are shown (d). A similar crank handle to the previous ones (b) is supported on a forked stick at the end of the rope machine. This handle is turned in reverse (counterclockwise) to the cranks (c) to twist the connected strands together. These are "laid up" by one or more of the feeders.

Mortice: A usually rectangular cavity in a piece of material, as wood or stone, for receiving a tenon.

The first strand should be turned clockwise, then the laying up of the strands will be done counterclockwise and the next laying will again be clockwise. Proof that the rope is well made is that the individual fibers lay lengthways along the rope.

In the process of laying up the strands, the actual twisting together or laying will take some of the original "twist" out of the strand which has not yet been laid. Therefore, it is necessary to keep twisting the strands while laying together.

When making a rope too long to be spun and laid in one piece, a section is laid up and coiled on the ground at the end of the rope walk farthest from the cranks. Strands for a second length are spun, and these strands are married or spliced into the strands of the first section and then the laying up of the second section continues the rope.

The actual "marrying" of the strands is done only in the last lay, which makes the rope when completed. The ends where the strands are married should be staggered in different places. By this means, rope can be made and extended in sections to a great length.

After a complete length of rope is laid up, it should be passed through the fire to burn off the loose ends and fibers. This will make the rope smooth and more professional looking.

Laying the Strands

The strands lie on the crossbar as they are spun. When the strands have been spun to the required length, which should not be more than about a hundred feet, they are joined together by being held at the far end. They are then ready for laying together. The turner, who is facing the cranks, twists the ends together counterclockwise, at the same time keeping full weight on the rope which is being laid up. The layer advances placing the strands side by side as they turn.

It is important to learn to feed the material evenly, and lay up slowly, thereby getting a smooth even rope (fig. 3-82). Do not try to rush the ropemaking. Speed in ropemaking only comes with practice. At first it will take a team of three or four up to 2 hours or more to make a 50-yard length of rope of three lays, each of three strands; that is, nine strands for a rope with a finished diameter of about 1 inch. With practice, the same three or four people will make the same rope in 15 to 20 minutes. These times do not include time for gathering material.

In feeding the free ends of the strands, twist in the loose material fed in by the feeder. As the feeders move backward, they must keep a slight tension on the strands.

Making Rope with a Single Spinner

Using a Single Crank. Two people can make a rope, using a single crank. A portion of the material is fastened to the eye of the crank, as with the multiple crank. Supporting crossbars, as used in a ropewalk, are required when a length of more than 20 or 30 feet is being spun.

Feeding. If the feeder is holding material under the left arm, the right hand is engaged in continuously pulling material forward to the left hand which feeds it into the turning strand. These actions, done together as the feeder walks backward, govern the thickness of the strands. The left hand, lightly closed over the loose turning material, must "feel" the fibers "biting" or twisting together.

When the free end of the turning strand, which is against the loose material under the arm, takes in too thick a tuft of material, the left hand is closed, and so arrests the twist of the material between the left hand and the bundle. This allows teasing out the overall "bite," with the right hand, thus maintaining a uniform thickness of the spinning strand.

Thickness of Strands. Equal thickness and twist for each of the strands throughout their length are important. The thickness should not be greater than is necessary with the material being used. For a grass rope, the strand should not be more than $^1/_4$ inch diameter; for coarse bark or palm, not more than $^1/_8$ or $^1/_{16}$ inch; and for fine bark, hair, or sisal fiber, not more than $^1/_8$ inch.

Common Errors in Ropemaking. There is a tendency with beginners to feed unevenly. Thin wispy sections of strand are followed by thick portions. Such feeding degrades the quality of rope. Rope made from such strands will break with less than $^1/_4$ of the tensile strain on the material.

Beginners are wise to twist and feed slowly. Speed, with uniformity of twist and thickness, comes with practice.

Thick strands do not help. It is useless to try and spin a rope from strands an inch or more in thickness. Such a rope will break with less than half the tensile strain on the material. Spinning "thick" strands does not save time in ropemaking.

Lianas, Vines, and Canes. Lianas and ground vines are natural ropes, and grow in subtropical and tropical scrub and jungle. Many are of great strength and useful for braiding, tree climbing, and other purposes. The smaller ground vines, when "braided", give great strength and flexibility. Canes and stalks of palms provide excellent material if used properly. Only the outer skin is tough and strong, and this skin will split off easily if the main stalk is bent away from the skin. This principle also applies to the splitting of lawyer cane (calamus), palm leaf stalks, and all green material. If the split starts to run off, bend the material away from the thin side, and it will gradually gain in size and come back to an even thickness with the other split side.

Bark Fibers. The fibers in many barks which are suitable for "ropemaking" are located near the innermost layers. This is the bark next to the sap wood. When seeking suitable barks of green timber, cut a small section about 3 inches long and 1 inch wide. Cut this portion from the wood to the outer skin of the bark.

The specimen should be peeled and the different layers tested. Green bark fibers are generally difficult to spin because of "gum" and it is better to search around for windfall dead branches and try the inner bark of these. The gum probably has leached out, and the fibers should separate easily.

Many shrubs have excellent bark fiber, and here it is advisable to cut the end of a branch and peel off a strip of bark for testing. Thin bark from green shrubs is sometimes difficult to spin into fine cord and is easier to use as braid for small cords.

Where it is necessary to use green bark fiber for rope spinning the gum will generally wash out when the bark is teased and soaked in water for a day or so. After removing from the water, the bark strips should be allowed to dry before shredding and teasing into fiber.

Braiding

One person may require a length of rope. If there is no help available to spin materials, it is necessary to find reasonably long material. With this material, one person can braid and make suitable rope. The usual three-strand braid makes a flat rope, and while quite good, it does not have finish or shape, nor is it as "tight" as the four-strand braid. On other occasions, it may be necessary to braid broad bands for belts or for shoulder straps. There are many fancy braids which can be developed from these, but these three are basic, and essential for practical woodcraft work. A general rule for all braids is to work from the outside into the center.

Three Plait

- The right-hand strand is passed over the strand to the left (fig. 3-83.1).
- The left-hand strand is passed over the strand to the right (fig. 3-83.2).
- This is repeated alternately from left to right (fig. 3-83.4).

Flat Four-Strand Braid

- The four strands are placed side by side. The right-hand strand is taken and placed over the strand to the left (fig. 3-84.1).
- The outside left-hand strand is laid under the next strand to itself and over what was the first strand (fig. 3-84.2).
- The outside right-hand strand is laid over the first strand to its left (fig. 3-84.3).
- The outside left strand is placed under and over the next two strands, respectively, moving toward the right.
- Thereafter, the right-hand strand goes over one strand to the left, and the left-hand strand under and over to the right (fig. 3-84-4).

Broad Braid. Six or more strands are held flat and together.

- A strand in the center is passed over the next strand to the left, as in figure 3-85.1.
- The second strand to the left of center is passed toward the right and over the first strand so that it points toward the right (fig. 3-85.2).
- The strand next to the first one is taken and woven under and over (fig. 3-85.3).
- The next strands are woven from left and right alternately towards the center (figs. 3-85.4 through 3-85.6). The finished braid should be tight and close (fig. 3-85.7).

To finish the broad braid.

- One of the center strands is laid back upon itself (fig. 3-86.1).
- Now take the first strand which it enclosed in being folded back, and weave this back upon itself (fig 3-86.2).
- Strand from the opposite side is laid back and woven between the strands already braided (fig. 3-86.3).
- All the strands should be so woven back that no strands show an uneven pattern, and there should be a regular under-over-under of the alternating weaves (fig. 3-86.4).
- If the braid is tight, there may be a difficulty in working the loose ends between the plaited strands.
- This can be done easily by sharpening a thin piece of wood to a chisel edge to open the strands sufficiently to allow the ends

being finished to pass between the woven strands.

- It should be rolled under a bottle or other round object and made smooth for final finishing.